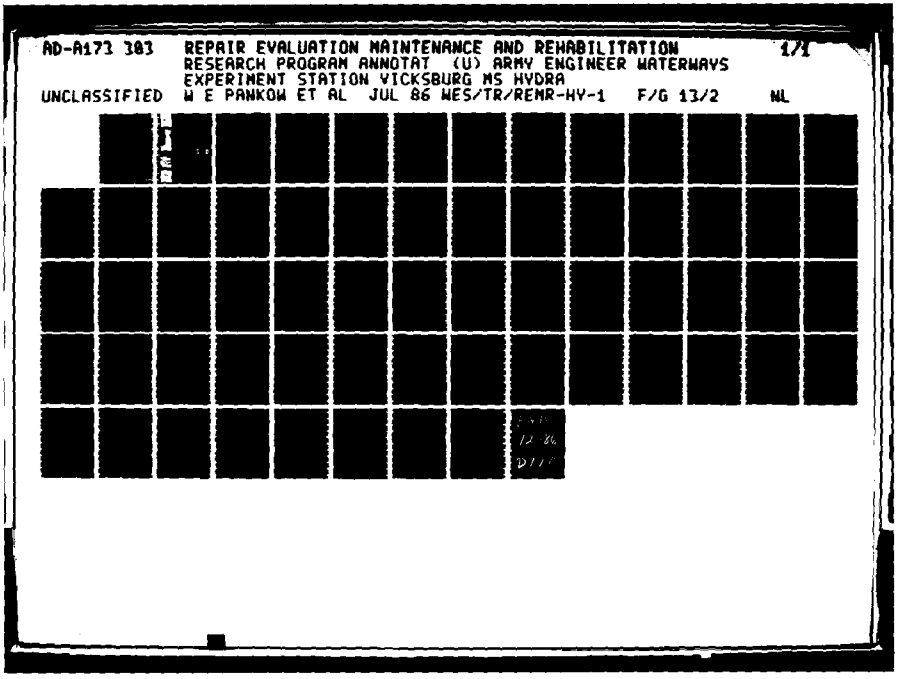
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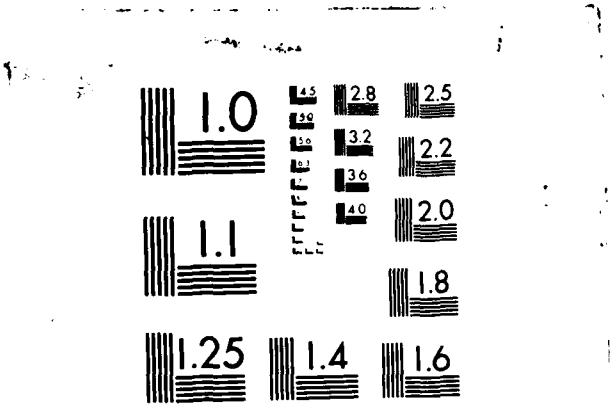

US Army Corps of Engineers

REMR RESEARCH PROGRAM

(12)

REPAIR, EVALUATION, MAINTENANCE, AND REHABILITATION RESEARCH PROGRAM

TECHNICAL REPORT REMR-HY-1

ANNOTATED BIBLIOGRAPHY FOR NAVIGATION TRAINING STRUCTURES

Compiled by

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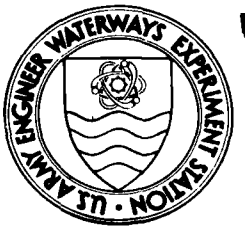
Estuaries Division

Hydraulics Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631



July 1986
Final Report

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Under Civil Works Research Work Unit 32323

The following two letters used as part of the number designating technical reports of research published under the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program identify the problem area under which the report was prepared:

	Problem Area		Problem Area
CS	Concrete and Steel Structures	EM	Electrical and Mechanical
GT	Geotechnical	EI	Environmental Impacts
HY	Hydraulics	OM	Operations Management
CO	Coastal		

For example, Technical Report REMR-CS-1 is the first report published under the Concrete and Steel Structures problem area.

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

COVER PHOTOS:

TOP — Training structure constructed to control shoaling near a river mouth. Slope failure of the outer end several years ago resulted in the loss of several hundred feet of the structure.

BOTTOM — Spur dike constructed from untreated Douglas fir and suffering from age deterioration. At the landward end of the structure, a landowner has placed stone in an effort to control sloughing of the riverbank.

Unclassified
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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The navigation projects of America have been the focus of a study to develop new and improved technology for repair and rehabilitation of estuarine and riverine deep- and shallow-draft training structures. Establishment of the Corps of Engineers Repair, Evaluation, Maintenance, and Rehabilitation Research (REMR) program has been the basis for the development of methods for detecting scour damage at these structures, setting up rationale for defining damaging scour, and identifying and evaluating techniques and equipment for repair of such damage.

This report, a bibliography, is to serve as a reference base. It is divided into three categories: General Overview, Scour and Scour Damage, and Repair Techniques.

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
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DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

PREFACE

A survey of related literature was conducted and this bibliography has been compiled by the Estuaries Division, Hydraulics Laboratory (HL) of the US Army Engineer Waterways Experiment Station (WES) for the US Army Corps of Engineers Repair, Evaluation, Maintenance, and Rehabilitation Research (REMR) program under Civil Works Research Work Unit 32323.

The survey was conducted by Messrs. Walter E. Pankow and Robert F. Athow, Jr., under the general supervision of Messrs. F. A. Herrmann, Jr., Chief of the HL, R. A. Sager, Assistant Chief of the HL, and W. H. McAnally, Jr., Chief of the Estuaries Division.

The REMR Directorate of Research and Development Coordinator in OCE was Mr. Jesse A. Pfeiffer, Jr., and members of the REMR Overview Committee in OCE were Messrs. John R. Mikel, Bruce L. McCartney, and Dr. Tony C. Liu. The WES REMR Program Manager and the Problem Area Leader were Messrs. William F. McCleese, Structures Laboratory, and Glenn A. Pickering, HL, respectively. This report was edited by Ms. Gilda Shurden, Information Products Division, WES.

Director of WES was COL Allen F. Grum, USA. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
degrees (angle)	0.01745329	radians
feet	0.3048	metres
hours	3.600	seconds
miles (US nautical)	1.852	kilometers
miles (US statute)	1.609347	kilometers

ANNOTATED BIBLIOGRAPHY FOR NAVIGATION TRAINING STRUCTURES

PART I: INTRODUCTION

Background

1. The US Army Corps of Engineers has established the Repair, Evaluation, Maintenance, and Rehabilitation Research (REMR) program to develop new and improved technology for extending the life of America's water resources projects. The Hydraulics Laboratory, Estuaries Division, of the US Army Engineer Waterways Experiment Station (WES) has been assigned two work units within the hydraulics problem area, that of scour detection and repair techniques for repair of navigation training structures.

Purpose

2. The objective of these work units is to develop methods for detecting scour damage at navigation training structures, to establish rationale for defining damaging scour, and to identify and evaluate techniques and equipment for repairing scour damage. Corps of Engineers practices concerning repair or rehabilitation of estuarine and riverine deep- and shallow-draft training structures will be defined and evaluated through these work units.

Approach

3. A survey of literature on scour detection, repair, and techniques for repair of navigation training structures was conducted to establish a reference base. This bibliography was generated from the survey and is an indicator of the lack of information actually published in this area of concern. The bibliography was assembled by searching the titles and volumes on file at the WES Technical Information Center and utilizing computer-aided key word searching systems.

4. During this search, it was discovered that most works were old or outdated, results of hydraulic model studies, or were theory and design oriented. Other pertinent references are listed as "For Corps of Engineers

Use Only" (as in the case of certain design memoranda), or in the case of foreign publications, an English translation may not be available. A more general approach was taken to include several applicable model studies and older "historical" references, while limiting the number of pure mathematical works.

Organization

5. The bibliography, given in Part II, is divided into three categories: General Overview, Scour and Scour Damage, and Repair Techniques.

6. Each entry has key words listed along with an abstract. Also listed is a REMR Interest line which indicates why the publication has usefulness in the REMR program.

PART II: BIBLIOGRAPHY

7. The first category in the bibliographical listing for navigation training structures offers an overview and general discussion of the subject in relation to the REMR project. Included in these references can be found such material as historical background, project accomplishments and follow-up, general guidelines, interest and analyses, and comparison of US and foreign examples. Each of the references is presented with key words, an abstract, and the related REMR interest.

8. Material pertinent to scour and scour damage and the techniques for the repair of such damage to navigation training structures can be found following the general overview section of references.

GENERAL OVERVIEW
SECTION

Abraham, C. E. 1975 (Feb). "Computer Use for River Regulation," Journal, Hydraulics Division, Vol 101, No. 2, pp 291-297.

Key Words: River regulation, stream flow

Abstract: The complexity that occurs in regulating multiple-purpose reservoir systems has necessitated the use of computer programs for scheduling reservoir regulation. The need for real-time use of scheduling computer programs coupled with the complexity of multiple-purpose reservoir regulation has made automated regulation schemes and interactive computer processing highly desirable. The scheduling engineer must be able to easily examine results of a trial computer simulation and modify operating constraints and forecasted information as necessary to retry the simulation. The package of stand-alone computer programs with interfacing capability is considered. These programs are used in real-time reservoir regulation and streamflow forecasting analysis in the North Pacific Division office of the Corps of Engineers. No optimization procedures are used, but experience indicates that the techniques used to simulate reservoir regulations, coupled with the interactive computer processing features, effectively provide good multiple-purpose system operation. (Author)

REMR Interest: Streamflow forecasting by computer simulation.

Ahmad, M. 1953. "Experiments and Design and Behavior of Spur Dikes," Proceedings IAHR, ASCE Joint Meeting, University of Minnesota.

Key Words: Scour, spur, spur dike, T-head spur, angle of approach, apron

Abstract: The problem of scour depth at a spur dike has been subjected to dimensional analysis to find different nondimensional terms which require study. Experiments have been made to study the effect of discharge intensity, sand grade, flow concentration, and angle of the spur dike to flow on the scour depth and scour pattern around a spur dike. A formula for calculating the scour depth at a spur dike nose for different conditions of flow concentration and angles of approach has been determined from these experiments. The shape of the falling apron in plans for different types of spur dikes and for various angles of approach to a T-head spur has been determined. Further work on spur dikes has been suggested. (Author)

REMR Interest: Different spur shapes, angle of flow approach, and spur angles were tested and the results are presented graphically so that scour development can be compared. Even though the date of the paper is 1953, it is a good presentation of the problem.

Alvarez, J.A.M. (Undated) "Hydraulic Resources - Design of Spur Dikes," Engineering School, University of Mexico.

Key Words: Dike, spur dike, wood, stone, permeable, channel, curve, scour

Abstract: This brief paper deals with bank erosion at river curves and the design of dikes to prevent it. After presenting the problem, several field and laboratory tests are described and, based on the results, outline important factors for the design of spur dikes. These factors are: ground plan location, length and separation of spurs, longitudinal slope of crest, angle to bank, permeability and scour.

REMR Interest: A presentation (figures and photos are missing) that addresses design considerations.

Berger, Louis, and Associates, Inc. 1980 (Dec). "Waterways Science and Technology," Draft Report for US Army Corps of Engineers National Waterways Study, East Orange, N. J.

Key Words: Navigation, locks, channel, river training, dredging

Abstract: A report consisting of six topics which encompass major areas of waterways science and engineering, one of which is river training technology (Section VI) and current trends. Draft Report.

REMR Interest: General overview with several US and foreign examples, and current trends and experiences.

Central Board of Irrigation and Power. 1956 (Dec). Manual on River Behavior, Control, and Training, Publication No. 60, New Delhi, India.

Key Words: River training, training work, groynes or spurs, cut-offs, navigation, hydraulic models, vanes, walls

Abstract: This comprehensive manual was published by the Board to aid field engineers and researchers in various aspects of flood control. The first four chapters deal with river behavior, flow, and sediment transport. Chapters 5-9 address specific problems and preventative measures (such as training works, stabilization, etc.) with example areas cited. Chapter 10 covers hydraulic modeling.

REMR Interest: Although design oriented, this 30-year-old manual is good text.

DuBoys, M. P. 1879. The Rhone and Rivers of Shifting Bed, translation from French, 1933, H. G. Doke, US Engineer Office, Memphis, Tenn.

Abstract: "Study of the regime of the Rhone and the action exercised by the waters on an indefinitely shifting bed of gravel." (Author)

REMR Interest: Historical value.

Enete, W. L. and Brooks, S. 1982. "User's Guide for the Potamology Data Processing System (PODAPS)," Automatic Data Processing Center, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Data collection systems and processing

Abstract: PODAPS is an integration of several analysis programs and a hydrologic data base for a user-oriented analysis tool. Analyze gage station and cross-sectional survey data for various studies. Output can be tabular with statistical computations forwarded to printer or graphics terminals.

REMR Interest: To analyze specific locations if proper data available.

Fairley, J. G., and Easley, R. T. 1967 (Mar). "Review of Past Experience with Contraction Works, Potamology Research Project 9," Report 21-2, US Army Engineer District, Memphis, Tenn. US Army Engineer Division, Lower Mississippi Valley, Vicksburg, Miss.

Key Words: History, contraction works, dikes

Abstract: A historical overview of contraction works during the 1927-1929 period covering specific dike works on the Tennessee, Arkansas, Missouri, and Mississippi Rivers is presented.

REMR Interest: Historical interest; provides insight as to project accomplishments or causes of failure.

Fairweather, V. 1973 (Dec). "Unpredictable Mississippi," Civil Engineering, Vol 43, No. 12, New York.

Key Words: Dikes, cutoffs

Abstract: This article gives a long-range flood control program that has four elements: levees; floodways; channel improvement and stabilization; and tributary basin improvements is described. The channel improvement and stabilization program is aimed at retaining the course of the river as well as at controlling floods. Control structures are described. The channel stabilization program includes dredging, dikes, cutoffs, and revetments. The revetment program involves the laying of concrete mattresses to prevent the river from wearing away banks. (Author)

REMR Interest: A basic outline.

Foster, J. E., and Franco, J. J. 1977 (Mar). "Lake Dardanelle, Arkansas River - Hydraulic Model Investigation," Technical Report H-77-4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: River improvements, training structures

Abstract: This study was conducted to determine the type and location of training and stabilization structures needed to develop a satisfactory navigation channel downstream of mile 238.5 to 231.3 on the Arkansas River.

REMR - General Overview

REMR Interest: An example hydraulic model study for a specific location/problem area.

Foster, J. E., O'Dell, C. R., and Franco, J. J. 1982 (Feb). "Development and Maintenance of Typical Navigation Channel, Red River," Technical Report HL-82-6, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Channel, navigation, sediments, shoaling, dikes, contraction, closure, cutoff

Abstract: Results are given of a model study on the Red River to determine whether man-made cutoffs, contraction works and dikes as proposed would be feasible to construct a 9-ft navigation channel in the existing 6-ft channel. The conclusions of testing several different plans are presented (flow dependent, shoaling, longer dikes, etc.).

REMR Interest: A shallow draft design oriented hydraulic model study.

Franco, J. J. 1982 (May). "Model-Prototype Comparison Study of Dike Systems, Mississippi River, Potamology Investigations," Technical Report HL-82-10, United States Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Dike, revetment, flow hydrograph, channel, problem reach, model study, model adjustments

Abstract: This report presents the results of movable-bed model studies of seven troublesome reaches of the Mississippi River to obtain some quick general indications of the effectiveness of plans proposed for the improvement and stabilization of those reaches. Even though the study time and facilities were limited to include little to no adjustment of the existing models, most of the principal trends predicted did occur in the river.

REMR Interest: Although of a general nature, due to the fact that the author lacked both time and facilities, this report contains post-construction condition surveys to compare with the modeled predictions. This report also reinforces the concept of reach specific studies instead of applying general concepts.

Franco, J. J. 1967. "Research for River Regulation Dike Design," Journal, Waterways and Harbors Division, ASCE, Vol 93, pp 71-87.*

Key Words: Dike design, dike crest elevation and profile, dike angle and position, current, channel alignment

Abstract: Flume tests were conducted and the performance and ratings are given for: three profiles, three systems, three alignments, and dike elevations. Several conclusions were given, including the following: stepped-down dike systems are more effective than level dikes; the amount of dredging is inversely proportional to the dike elevation, etc.

REMR Interest: Design oriented, but provides insight into maintentance and reasons for problems.

*(Note: Discussion by Gill in Vol 94, No. WW2, May 68, pp 263-266).

Grinevich, L. A., and Khavich, V. A. 1972. "Rational Ranges of Application of River Training Diking as Methods of Protecting Alluvial Land from Flooding," Nauka; Technika, Minsk, 276, pp 3-13, translated from Russian by US Department of Interior, Bureau of Reclamation, Division of Engineering Support, Translation Center, Book 1033, Paper No. 1, May 1977, Denver, Colo.

Key Words: Dikes, costs, channels

Abstract: A mathematical method of comparing two flood control measures: increasing channel capacity vs. dike construction. The method considers initial costs, repair, interest, etc., versus the economic losses of agricultural land.

REMR Interest: Construction planning.

Haas, R. H., and Weller, H. E. 1953. "Bank Stabilization by Revetments and Dikes," Transactions, ASCE, Vol 118, Paper No. 2564, pp 849-860.

Key Words: Bank stabilization, Lower Mississippi River, bank recession, revetment, structure, dikes, retards, groins, failure

Abstract: The problem of bank stabilization on the Lower Mississippi River is extremely complex. The primary problem is bank recession, therefore revetment is principal structure type employed; dikes, retards, and groins are installed to a lesser extent. For the most part, details of their design are peculiar to the lower river alone.

REMR Interest: Current dike methods at that time are covered; also failure of system due to ice, drift, vibration until sediment builds up in 3-4 years and decay are covered.

Hoffman, J. F. 1976. "Decrease in Harbor Maintenance Dredging Through the Use of Pile Dikes and Related Structures Together with an Analysis of Estuarine Sedimentation Problems," Energy-Environment Study Group, US Naval Academy, Annapolis, Md.

Key Words: Dredging, harbors, estuarine sediments, sediment control structures (i.e., groins, dikes, impermeable jetties, training walls)

Abstract: Most harbors of interest to the US Navy are located in estuaries that are a repository for sediments ranging from clay to fine sand. Maintenance dredging of channels is costly. Therefore, an alternate solution is presented: construction of reinforced concrete (organism-proof) pile dike clusters to trap sediments and periodically dredge around the dikes. Also proposed that this idea be modeled at WES for quantification of sediment and time-lapse photography.

REMR Interest: This report seeks methods other than dredging to maintain harbors.

Huval, C., et al. 1980 (Aug). "Deep Draft Navigation Channel Design Course, 11-14 August 1980, Training Course Notes and References," US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Deep draft, channel, design

Abstract: This publication is a compilation of papers given at the course and relates more to the design of channels utilizing ship model simulators, and vessel data, safety, channel marking, etc. Channel erosion and bank stability are addressed in view of ship created wave damage, etc.

REMR Interest: Although vessel oriented, it does address the problem of wave damage to river banks and structures.

Hyde, G. E., and Beeman, O. 1963 (Jan). "Improvements of the Columbia River by Dredging and Construction Works," Proceedings, Federal Inter-Agency Sedimentation Conference, USDA, Agriculture Research Service Misc. Publication No. 970, Paper No. 53, pp 454-461.

Key Words: Dredging, sediment

Abstract: This publication reviews work on Columbia River, 1957-1961 and is basically dredging and spoil use.

REMR Interest: Oriented toward origin of sediment, transport, build-up, and removal.

Inglis, C.C. 1947 (Jan). "Meanders and their Bearing on River Training," Maritime and Waterways Engineering Division Meeting, the Institution of Civil Engineers, Paper No. 7, Poona,India.

Key Words: River flow, meander, sediment transport, river training, groynes

Abstract: This paper, and included discussions by others, addresses the river's natural response to meander. This tendency is described and discussed in detail with its bearing on training. The concern is for the placement of bridges and training structures and the relative change of the river over time.

REMR Interest: This paper presents many problems that should be addressed in planning and design stages.

Inglis, C. C. 1949. "The Behavior and Control of Rivers and Canals," Research Pub. 13, Central Waterpower Irrigation and Navigation Research Station, Pt 1, Poona, India.

Key Words: Dikes, groins, channel, scour, model studies

Abstract: This publication is rather complete with several site specific problems, associated hydraulic model studies, and recommended solutions. Unfortunately, the material is dated as are the references. (Note: Published when the station was the India Waterways Experiment Station.)

REMR Interest: Historical value.

Inglis, C.C., and Kestner, F.J.T. 1958 (Mar). "The Long-Term Effects of Training Walls, Reclamation, and Dredging on Estuaries,"Proceedings, Institution of Civil Engineers, Paper No. 6268, Vol 9, pp 193-216, London, England.

Key Words: Training walls, effects of..., energy, scour

Abstract: After a short introduction, the changing conditions in the Syre Estuary in Lancashire during the 1950's are described in detail and the reasons for the changes explained. The explanations are based on observations carried out in the estuary and in a mobile-bed model in which the effect of training the river in its lower middle reach was examined. The harmful effects of constructing a weir across the estuary were also demonstrated. Conditions in the untrained Wyre Estuary are then compared with those in the adjoining Lune Estuary, which was carefully surveyed between 1838 and 1844, partially surveyed in 1851 after training works had been constructed, and again in detail in 1955-56, some time after the estuary had established its trained regime. The immediate and long-term effects of the Lune training works are then explained. The accretion/erosion balance in estuaries as conditioned by regime is next discussed, with special reference to the Wash. Finally, present knowledge of the relation of free and suppressed meandering on the one hand, and regime on the other, is set forth in detail, with applications to particular cases.

REMR Interest: Refers to tidal flow and sedimentation/accretion in two specific "estuaries." The paper addresses cause and effect, before and after training walls are added, to estuaries.

Inglis, C.C., and Kestner, F.J.T. 1958 (Dec). "Changes in the Wash as Affected by Training Walls and Reclamation Works," Paper No. 6340, Proceeding, Institution of Civil Engineers, Vol 11, pp 435-466, London England.

Key Words: Trainings walls, effects of..., energy, scour

Abstract: In the Wash, engineering problems arose in connection with land drainage reclamation and navigation. Though interdependent, the interests involved and the best solutions differ widely and are, to a certain extent, in opposition. This paper describes the changes that have taken place in the loose boundary of the Wash in historic times, with particular reference to the effects of engineering works constructed to reclaim land, to train navigation channels, or to improve lowland drainage. Field studies to determine what changes are taking

place today are described. These are based on levels and core samples taken at points on cross sections which traverse both the mud belt and the sand areas to seaward. The results of these studies have been linked with observations of concentrations of suspended silt from different stations in the Wash. Short-term changes observed in this way have been compared with long-term changes, which have occurred between successive surveys carried out by the Admiralty and Ordnance Survey since 1828. The mechanisms of accretion and scour, and the marked accellerating effect of engineering works on the rate of accretion, are also described. (Author)

REMR Interest: (Similar to Inglis and Kestner, Mar 1958) A historical treatment of the Wash area, i.e., silting and erosion, flow, etc., before and after training works.

International Association for Hydraulic Research. 1981 (Feb). "Proceedings -19th IAHR Congress, New Delhi, India," Vol I through V.

Key words: Modeling, river regulation, sediment

Abstract: Vol II through V of the Proceedings contain 185 papers presented at the meeting, 18 of which are in French with English abstracts; Vol I contains abstracts of all of the papers. The papers are grouped under general topics that include sedimentation engineering for rivers and reservoirs, coastal and hydraulic engineering, hydraulics in river basin development and operation, and hydraulic research and modeling techniques. Specific subjects covered include mechanics of reservoir sedimentation, water and sediment gauging of streams, measurement techniques for reservoir sedimentation, modeling for predicting effects of river regulation, storm surges in coastal zones, low-cost beach defenses, littoral drift, wastewater and cooling water discharge structures, filtering and simulation techniques, optimal operation of water resource systems, incorporation of economic evaluation into models for river basin development, criteria for model-prototype conformity, new developments in laboratory and field instrumentation, computer applications, and others.

REMR Interest: Computer modeling of various riverine topics.

Littlejohn, B. J. 1969 (May). "Investigation of Existing Dike Systems, Potamology Research Project 9," Report 21-3, US Army Engineer District, Memphis, Tenn., US Army Engineer Division, Lower Mississippi Valley, Vicksburg, Miss.

Key Words: Dike, problem reaches, channel, scour

Abstract: This report investigates post construction follow-up on dike systems built during 1959 to 1962 period in problem reaches on the Mississippi River. A description of the reach and developments since installation is given for Wrights Point Reach, Ashport-Golddust and Kate Aubrey Reach, and Lookout Bar Reach.

REMR Interest: Provides project follow-up.

Keown, M.P., Dardeau, E.A. Jr., and Causey, E. 1981. "Characterization of the Suspended-Sediment Regime and Bed-Material Gradation of the Mississippi River Basin," Report 1, Vol 1 and 2 of 2, Potamology program, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Bed load, Mississippi River Basin, sediment transport, suspended sediment load

Abstract: A comprehensive study is given of physical forces which influence the flood carrying capacity and navigability of the lower Mississippi River. The various tributary basins are individually characterized to include sediment and bed materials and then compared to those found in the lower Mississippi River both in the 1980's and in a previous study in 1932-4. Fractions, in percentages, for gravel, sand, and silt are compared as are selected grain sizes.

REMR Interest: Grain size of suspended sediment and bed material along with flow is important in studying structures for abrasion capabilities, extent of scour, etc.

Karaki, S.S. 1959 (Sep). "Hydraulic Model Study of Spur Dikes for Highway Bridge Openings," Colorado State University, Fort Collins, Colo.

Key words: Spur dikes, design, bridge pier, scour

Abstract: This publication presents the results of a flume study for design criteria for spur dikes at highway bridges. A limited use design curve is presented. The curve is limited due to model constraints, i.e., uniform approach flow, short period test time, etc.

REMR Interest: A design oriented study but in conjunction with bridge piers.

Maher, T.F. 1964 (Feb). "Study of Effect of Regulation Works on Stream Flow," Transportation Engineering Conference, ASCE, St. Louis, Mo.

Key words: River regulation, dikes

Abstract: A historical overview is presented of the Mississippi River from the 1900's to the 1950's. Flow, stage discharge, etc. is reviewed and compared with dikes and structures added.

REMR Interest: Historical overview.

Mamak, W. 1964. "River Regulation," US Department of the Interior and the National Science Foundation, Washington, DC.

Key Words: River regulation, contraction, sediment, dikes, design, regulation structures

REMR - General Overview

Abstract: This work is actually a translation for the US Government from the earlier edition published in Warsaw, Poland by Arkady in 1958. The text is rather complete on various aspects of regulation. Chapters deal with fundamentals, river properties, regulation structures - types and designs and several cases.

REMR Interest: Good design reference even though the rules, regulations, and economics deal with Poland in the 1950's.

"Minutes of the Symposium on Design of Groins and Dikes at the Waterways Experiment Station on 14-15 March 1978."

Key Words: Design, dikes, groins, model tests, Corps of Engineer Districts, current practice

Abstract: Twelve Corps of Engineer Districts/Divisions representatives attended a WES-sponsored symposium to discuss current practice in design of groins and dikes in rivers. Discussions included: long- and short-term river responses, contraction, sills, stone dike construction to include length, angle, and design criteria. All agreed that general design parameters and research is required.

REMR Interest: An outline of various design practices and problems encountered.

Odgaard, A.J., and Kennedy, J.F. 1983 (Aug). "River-Bend Bank Protection by Submerged Vanes," Journal, Hydraulic Engineering, ASCE, Vol 109, No. 8, pp 1161-1173.

Key Words: Physical model, submerged vanes, river, channel

Abstract: It is shown, theoretically and by a physical model, that short, vertical, submerged vanes installed at incidence to the channel axis in the outer half of a river-bend channel significantly reduce the secondary currents and the attendant undermining and high-velocity attack of the outer bank. The effect of the vanes on the secondary flow is estimated by a simple torque calculation using the Kutta-Joukowski theorem. A design relation for the vane spacing is derived by equating the torque, about the channel centroid, produced by the flow curvature to that resulting from the lateral force exerted on the vanes. The relation is verified in an idealized, physical model of a bend of the Sacramento River, California. (Author)

REMR Interest: Although the vanes are intended as bank protection on channel bends to reduce secondary flow, they may also prove useful to help reduce maintenance and repair when used in conjunction with other training structures.

Odgaard, A.J., and Lee, H-Y, E. 1984 (July). "Submerged Vanes for Flow Control and Bank Protection in Streams," IIHR Report No. 179, Iowa Institute of Hydraulic Research, University of Iowa, Iowa City, Iowa.

Key Words: Vanes, velocity, alluvial channel, flow

Abstract: This study has evaluated the effectiveness of Iowa Vanes in reducing depth and velocity near the outer bank in a curved, alluvial channel flow. A procedure for the design of a vane system for a given river curve has been developed and tested in a laboratory model and used for the design of an Iowa-Vane bank-protection structure in the East Nishnabotna River (US Hwy. 34 at Red Oak, Iowa).

REMR Interest: Provides a design procedure with model tests.

Office, Chief of Engineers, Department of the Army. FY-_. "FY-_ Annual Report of the Chief of Engineers on Civil Works Activities," Washington, DC.

Abstract: The annual reports, by fiscal year, track all civil works projects, new and on-going for costs, status, etc. They are listed by Division and Districts.

REMR Interest: River training structures and contraction works are also listed.

Office, Chief of Engineers, Department of the Army. 1981 (Sep). "Deep-Draft Navigation Project Design," ER 1110-2-1404, Washington, DC.

Key Words: Design, deep-draft, river, channel

Abstract: "This regulation prescribes the design procedure and rationale for development of a deep-draft navigation project."

REMR Interest: Project planning and design phases.

Office, Chief of Engineers, Department of the Army. 1965 (Aug). "Tidal Hydraulics," EM 1110-2-1607, Washington, DC.

Key Words: Channel, control works, training dikes, regularization

Abstract: This manual serves as a guide to Corps of Engineers personnel engaged in the solution of tidal hydraulics problems. Thirty-seven pages with glossary are included.

REMR Interest: A basic design guide that briefly mentions training structures.

Office, Chief of Engineers, Department of the Army. 1981 (Dec). "Layout and Design of Shallow-Draft Waterways," EM 1110-2-1611, Washington, DC.

Key Words: Waterways, shallow-draft, design

Abstract: An engineering and design manual to provide guidance for planning, layout, and design of shallow-draft waterways.

REMR Interest: A general design manual but is specific for shallow-draft navigation channels.

Office, Chief of Engineers, Department of the Army. 1982 (Oct). "Ice Engineering," EM 110-2-1612, Washington, DC.

Key Words: Ice, ice jams, control, dispersion, ice forces on structures

Abstract: This manual presents guidance for the planning, design, construction, and operation and maintenance of ice control and ice suppression measures for Corps of Engineers projects. A few of the topics covered are: ice formation and characteristics, ice jams, ice adhesion and control, and ice forces on structures.

REMR Interest: Chapter 9, "Ice Forces on Structures," deals with piles and piers and their protection.

Office, Chief of Engineers, Department of the Army. 1983 (Apr). "Engineering and Design - Hydraulic Design of Deep-Draft Navigation Projects," EM 1110-2-1613, Washington, DC.

Key Words: Design, channel, navigation

Abstract: The manual provides guidance for the layout and design of deep-draft navigation projects.

REMR Interest: Planning and design of navigation structures.

Pokrefke, T. J., Jr. 1977 (Dec). "Design of Stone Spur Dikes," for Dr. V. L. Zitta, CE-8553, Mississippi State University. Also part of the "Minutes of the Symposium on Design of Groins and Dikes at the Waterways Experiment Station on 14-15 March 1978."

Key Words: Historical overview, design, construction, dikes, groins

Abstract: This is a graduate school paper giving a historical overview concerning the design of groins and dikes, and follows the development of dikes from 1815 to 1964. The review includes the development of dikes on the Missouri, Mississippi, Arkansas, Ohio, and Tennessee Rivers and the various types of dikes used on these rivers. It is an overview comparing and contrasting various authors, existing projects, model studies, etc. A few of the characteristics reviewed are: materials, width, height, profile, slope, angle of dikes, etc. Specific projects are cited on several rivers and their design and construction are reviewed. Finally, an analysis is presented on the stone spur dikes for Smithland Locks and Dam. (22 pages including references)

REMR Interest: Historical overview.

Schoklitsch, A. 1937. "Part X: River Engineering," Hydraulic Structures, A Text and Handbook; Vol II, American Society of Mechanical Engineers, New York, N. Y.; Translated by S. Shulits, Reviewed by L. G. Straub, Plimpton Press, Norwood, Mass.

Key Words: navigation, training structures, dikes

Abstract: A now historical work for training structures, this paper was written during the 1920's and 30's in Europe.

REMR Interest: Historical value.

Shen, H. W. 1971. River Mechanics, edited and published by H. W. Shen, Colorado State University, Fort Collins, Colo.

Key Words: River flow, alluvial, bed, sediment, measurements, instrumentation, stability, regulation, control, scour, salinity

Abstract: This book is based on lecture notes delivered at the Institute on River Mechanics, Colorado State University, June, 1970. The 32 chapters have been modified or expanded to present current knowledge on various aspects of alluvial river probelms.

REMR Interest: The chapters deal with flow, sediment, transport, and stability and may be used in analysis.

Taccarino, Paul A. 1981 (Aug). "Bibliography of Post Authorization Reports (Design Memoranda) of Civil Works Projects of Corps of Enginneers," US Army Engineer Waterways Experiment Station, Special Projects Branch, Technical Information Center, Vicksburg, Miss.

Key Words: bibliography

Abstract: This is a compilation of Design Memoranda by Districts and Divisions, with dates listed as the studies were issued and not necessarily when approved. Many training works are listed but not all are available at the WES Technical Information Center.

Note: Many of the memoranda are for Corps of Engineers use only.

REMR Interest: Construction plans and cost estimates are shown in some cases.

Thomas, B. F., and Watt, D. A. 1913. The Improvement of Rivers, Vol 1, 2nd ed., Wiley, New York.

Key Words: rivers, improvement, regulation, dikes

Abstract: A treatise on the methods employed for improving streams for open navigation covering the principles of most importance and the problems of actual practice.

REMR Interest: Historical background on types of regulation and several example locations.

Tuttle, J. R., and Pinner, W. 1982. "Analysis of Major Parameters Affecting the Behavior of the Mississippi River," Potamology Program Report 4, US Army Engineer Division, Lower Mississippi Valley Division, Vicksburg, Miss.

Key words: Hydrology, sedimentation, channel, channel geometry, levees, cutoffs, revetments, dikes

Abstract: The report focuses on detailed investigations of four major parameters: hydrology, sedimentation, channel geometry, and man-made modifications. A cause-effect relationship between river behavior and man-made modifications is examined, i.e.: river reach, stage, flood control, sediment transport, deposition and scour versus levees, dikes, revetments, and cutoffs. Recommends that construction/repair/maintenance of problem areas be accomplished and coordinated regardless of District boundaries to minimize side effects on flood control structures, top bank width, channel alignment, and balance between hydraulic parameters and sediment transport. A brief overview of the man-made modifications is presented along with their relative success and interaction with each other and river behavior.

REMR Interest: An explanation of man-made modifications and their cause/effect relationships.

United Nations Economic Commission for Asia and the Far East, Bureau of Flood Control, 1953. "River Training and Bank Protection," Flood Control Series No. 4.

Key words: River training, revetment, bank, bed, dike, flood control

Abstract: In this study, emphasis is given to the training of rivers and attempted mainly to change the configuration of their beds. Methods of bank protection also are given. One section deals with river work practice in other regions (US, Europe, New Zealand, Australia).

REMR Interest: General concern is bank protection.

US Army Corps of Engineers, 1984. "Shore Protection Manual," Coastal Engineering Research Center, Waterways Experiment Station, Vicksburg, Miss.

Key words: Design, (ocean) shore protection, wave forces

Abstract: The manual presents methods and design of shore protection; although mainly ocean oriented, jetties, breakwaters, and bulkheads are included.

REMR Interest: In areas where short-period waves are a consideration.

US Army Engineer Committee On Channel Stabilization, 1963. "Symposium on Channel Stablilization Problems," Technical Report No. 1, Vol 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key words: Stabilization problems, channel stabilization, maintenance, structures

Abstract: Seven chapters review channel stabilization problems in distinct areas and conclude with recommended research, studies, and model investigation of river sedimentation.

REMR Interest: General interest.

US Army Engineer Committee on Channel Stabilization, 1964. "Symposium on Channel Stabilization Problems," Technical Report No. 1, Vol 2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key words: Regulation, river control structures, channel stabilization, dikes

Abstract: Chapters 1 and 2 deal with general design whereas Chapters 3 through 8 deal with specifics on the Arkansas River such as channel design and stabilization, cut-offs and hydraulic aspects of stabilization.

REMR Interest: Chapters deal with specific areas focusing on needs, problems, costs, and maintenance. Aerial photographs, maps, and plans of structures are included.

US Army Engineer Committee on Channel Stabilization, 1966 (Nov). "Channel Stabilization Publications Available in Corps of Engineers Offices," Technical Report No. 4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key words: Channel stabilization, geomorphology, channel geometry, sedimentation, hydraulics, hydraulic models, soils investigations, instrumentation and field surveys, channel improvement and stabilization measures

Abstract: A listing of publications grouped under key word headings that were available in 1966 are presented.

REMR Interest: The works are pre-1966, but they are abstracted and may be useful as background information.

US Army Engineer Committee on Tidal Hydraulics, 1980 (Dec). "Bibliography on Tidal Hydraulics, Supplementary Material Compiled from June 1974 to June 1980, Tidal Flows in Rivers and Harbors," Report No. 2, Supplement No. 8, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key words: Bibliography, regulation, improvement, training structures, dredging

Abstract: Section V, pp 157 to 168, Regulation and Improvement, contains abstracts of works mainly on model studies and dredging but several on training structures.

REMR Interest: Supplements 1 through 8 are additional sources of general information available.

US Army Engineer District, Memphis. 1982 (Dec). "Channel Stabilizaton Study," Potamology Program, Report 3, Memphis, Tenn.

Key Words: Channel stabilization, mathematical models, Mississippi River

Abstract: This study to determines the effect of channel stabilization features on water surface profiles, channel geometry development and applies this information for future analysis of problem areas and design of stabilization features.

REMR Interest: A mathematical approach for channel analysis.

US Army Engineer District, Memphis. 1981. "Mississippi River - Channel Improvement Data Report," Memphis, Tenn.

Key Words: Maintenance, costs, repair, river channel

Abstract: A summary of conditions of the various river structures within the District's area is given. Data presented are: original conditions, original project, construction costs, and date, cost, and type of repair/maintenance.

REMR Interest: The data are useful as to type of repair and cost. Further information is needed to learn the cause of the problem, what costs were actually dredging, etc.

US Army Engineer District, New Orleans. 1973. "Channel Improvement Data Report, FY 1973," New Orleans, La.

Key Words: Maintenance, costs, repair, river channel

Abstract: This report summarizes conditions of the various river structures within the District's area. Data presented are: original conditions, original project, construction costs, and date, cost, and type of repair/maintenance.

REMR Interest: The data are useful as to type of repair and cost. Further information is needed to learn the cause of the problem, what costs were actually dredging, etc.

US Army Engineer District, New Orleans. 1974 (Jul). "Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana - Feasibility Report, Improved Approaches," Appendixes, New Orleans, La.

Key Words: Study, deep-draft, channel, training works, spur dikes, economics

Abstract: The results are given of a feasibility study to widen and deepen the Lower Mississippi River navigation channel for anticipated future vessel traffic.

REMR Interest: Design and location of training structures (spur dikes) is given.

US Army Engineer District, New Orleans. 1939. "The Passes, Mississippi River," New Orleans, La.

Key Words: The passes, jetties, channels, bar, sill, spur dikes, jetty maintenance, subsidence

Abstract: This document represents a historical overview of the passes including flows, flooding, transportation importance, and controls initiated in the 1850's through post-storm reconstruction in 1939. It outlines construction of permeable pile dikes and rehabilitation of concrete capped stone jetties, also the installation (1918 and 1935) of spur dikes for contraction.

REMR Interest: Historical value.

US Army Engineer District, Omaha. 1982 (Mar). "Riverine Habitat and Floodway Restoration: Missouri River, Sioux City, Iowa, to the Mouth near St. Louis, Missouri: An Evaluation of the Notched Structures in Creating Additional Backwater Areas," MRD Sediment Series No. 24, Omaha, Neb.

Key Words: Navigation, channel, dike, deposition, notch, backwater, flow

Abstract: The Omaha and Kansas City Districts initiated a notching program during the 1975 navigation season. The notches would provide a means for water to pass through and between the rock structures and prevent sediment deposition downstream while enhancing the shallow water habitat. This report summarizes the achievements of the 5-year program and 1,306 notches. Based on data collected, no single notch design criteria could be used for the range of conditions which exist on the river. The most effective notching program is one that provides a continuous source of quiet water areas over the widest possible range of discharges.

REMR Interest: The report lists priorities and general guidelines for a notching program which could be made a part of the structure evaluation process.

US Army Engineer District, Portland. 1975 (Jul). "Columbia and Lower Willamette River Environmental Statement," Portland, Oreg.

(Inside subtitles: Final Environmental Impact Statement-Columbia and Lower Willamette River Maintenance and Completion of the 40-ft Navigation Channel Downstream of Vancouver, Wash., and Portland, Oreg.)

Key Words: Channel, deepening, navigation

Abstract: The final EIS for completion of the channel deepening from 35 to 40 ft, and channel maintenance.

REMR Interest: General interest and project description.

US Army Engineer District, Seattle. 1962 (Feb). "Everett Harbor and Snohomish River, Washington - General Design Memorandum," Seattle, Wash.

Key Words: Modification, widen, channel settling basin

Abstract: This modification consists of widening and extending a channel 8 ft deep and 150 ft wide from the existing settling basin at 14th Street, Everett, Wash., to the head of Steamboat Slough, with a settling basin near the upstream edge.

REMR Interest: Dredging oriented project.
(NOTE: For Corps of Engineers Use Only)

US Army Engineer District, Seattle. 1957 (Jan). "Everett Harbor and Snohomish River, Washington; General Design Memorandum; Channel and Settling Basin Dredging and Spur Dike Construction," Seattle, Wash.

Key Words: Channel, enlarge, realign, settling basin, spur dike (timber), gravel fill spur dike.

Abstract: This report gives an improvement plan to realign and enlarge to a depth of 15 ft and widths of 150 to 425 ft, that portion of the existing channel extending from deep water in Port Gardner to the settling basin; deepening the settling basin to 20 ft; and constructing a spur dike extending westward from Preston Point (a distance of approximately 1,800 ft). The dike will divert more of the river flow westward and reduce annual dredging.

REMR Interest: Dike plans and details are given.
(NOTE: For Corps of Engineers Use Only)

US Army Engineer District, Vicksburg. 1966 (Mar). "Evaluation of Dike Systems - Baleshed and Ajax Bar Reach (Mile 495.8 - 479.8 AHP). Study of Effects of Baleshed Landing Dike System," Potamology Studies, Report 1-1, Vicksburg, Miss.

Key Words: Dike, planning, design, reach, construction problems and difficulties, stone, stage

Abstract: This report is an evaluation of changes in various channel characteristics which were attributable to construction of Baleshed

Landing Dikes. A general overview is presented on the reach, design and construction of the dikes, construction problems, and continuing studies. The stone dikes have variable heights of 15 to 30 ft.

REMR Interest: Project follow-up: area prior to construction, design, construction, problems, and changes to reach after construction; maintenance and repair.

US Army Engineer District, Vicksburg. 1983. "Channel Improvement Data Report, FY 1983," Vicksburg, Miss.

Key Words: Maintenance costs, conditions, river channel

Abstract: This report summarizes conditions of the various structures within the District's area of the Arkansas and Mississippi Rivers. Data presented are: original conditions, original project, construction costs, and date, cost, and type of repairs/maintenance.

REMR Interest: The data are useful to type of repair and costs. Further information is needed to learn the cause of the problem, what costs were actually dredging, etc.

US Army Engineer Division, Lower Mississippi Valley, Potamology Branch. 1982. "Analysis of Major Parameters Affecting the Behavior of the Mississippi River," Vicksburg, Miss.

Key Words: Dikes, river behavior, Mississippi River

Abstract: A description is presented of how man-made modifications (levees, dikes, revetments, and cutoffs) have influenced river behavior.

REMR Interest: A general analysis of changes.

US Army Engineer Division, Missouri River. 1984 (Sep). "Laboratory Investigation of Vane Dike River Control Structures," Report No. MRD-11, Omaha, Neb.

Key Words: Vane dikes, hydraulic model study, river flow, sedimentation

Abstract: Presented in this report are the results of a model study on river training structures called vane dikes. The purpose of this investigation was to determine the relative effects of vane dikes on the flow distribution and bed configuration of a typical Missouri River bend. Different structure arrangements were tested to determine the optimum vane dike configuration by which the flow could be diverted away from the bank. Tests were also conducted to determine the effectiveness of the vane dike structures in the removal of point bars along convex banks and the variations in the sediment deposition landward (wet lands) of the vane dikes under various combinations of vane and gap lengths. (Author)

REMR Interest: Model studies that indicate the effectiveness of vane dikes in various applications.

US Army Engineer Division, Missouri River, US Army Engineer Districts, Omaha and Kansas City. 1966 (Nov, revised Nov 1971). "Laboratory Investigation of Underwater Sills on the Convex Bank of Pomeroy Bend," MRD Hydraulic Laboratory Series Report No. 2, Mead Hydraulic Laboratory, Omaha, Neb.

Key Words: Sill, navigation channel, sill length, spacing, angle of attack, flow, scour

Abstract: This report presents the results of a model study performed on Pomeroy Bend which is located in the Missouri River just north of Kansas City, Mo. The purpose of the study was to determine effective flow control to maintain an adequate navigation channel through a long flat bend by the use of underwater sills. Various configurations studied included heights, lengths, spacing, and angle on the convex bank of flat bends especially during high discharges. The conclusion not only provides recommendations, but also the negative aspects of the structure configurations not recommended.

REMR Interest: The report reinforces the need for site/reach-specific study over general application, however, could aid in the evaluation of similar structures.

US Army Engineer Waterways Experiment Station. 1981. "Final Report to Congress, The Streambank Erosion Control Evaluation and Demonstration Act of 1974, Section 32, Public Law 93-251, Appendix A - Literature Survey and Preliminary Evaluation of Streambank Protection Methods," TP H-77-9, Vicksburg, Miss.

Key Words: Literature survey, streambank erosion, mechanisms of erosion, evaluate methods

Abstract: This report is a preliminary study of streambank erosion control with emphasis on an extensive literature survey. Also preliminary investigations to identify mechanisms that contribute to streambank erosion and evaluate the effectiveness of widely used streambank protection methods. (Note: report consists of Appendix A through Appendix H.)

REMR Interest: Appendix A contains numerous references on river training structures and streambank protection.

US Army Engineer Waterways Experiment Station. 1981. "Final Report to Congress, The Streambank Erosion Control Evaluation and Demonstration Act of 1974, Section 32, Public Law 93-251, Appendix B - Hydraulics Research," TP H-77-9, Vicksburg, Miss.

Key Words: Channel and bank stability, protection, navigation, model studies

Abstract: This appendix covers various phases of bank stability and protection under various controlled modeling conditions. Topics include channel flow protection, bank protection utilizing spur dikes and gabions, effects of navigation, and wave studies.

REMR Interest: Contains discussion of spur dikes and scour with model photos of bed and flow patterns.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1981 (Mar). "Coastal Engineering Technical Note, Groins - Their Application and Limitations," Coastal Engineering Notebook, CETN-III-10, Vicksburg, Miss.

Key Words: Groin, stone, timber, permeability, height spacing, length, material

Abstract: This Technical Note is a brief and general discussion concerning groins. Topics considered are functional applications and limitations, structural aspects, design, and materials. For more information, the Shore Protection Manual should be reviewed.

REMR Interest: Although the report is coast oriented, key words could be substituted for the riverine environment, i.e., sediment transport and flow for longshore current, etc. Many of the considerations for groins also apply to dikes.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1982 (Jun). "Coastal Engineering Technical Note, Protecting Timber Piles in Seawater Environments," Coastal Engineering Notebook, CETN-III-14, Vicksburg, Miss.

Key Words: Timber piles, marine organisms, preservative treatments

Abstract: This Technical Note is a brief and general discussion concerning the protection of timber piles. Topics considered are marine organisms, preservatives, and repair.

REMR Interest: Useful where marine organisms are prevalent.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1982 (Jun). "Coastal Engineering Technical Note, Geotechnical Sampling Guidelines for Rubble-mound Coastal Structures," Coastal Engineering Notebook, CETN-III-15, Vicksburg, Miss.

Key Words: Soil exploration, sampling, procedure, boreholes, jetties, breakwaters, foundations

Abstract: This Technical Note provides a brief guide to soil sampling for rubblemound coastal structures. The reconnaissance, preliminary exploration, detailed design exploration, and construction monitoring phases that are outlined also apply to riverine construction.

REMR Interest: Similar use in sampling for stone dikes.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1983 (Nov). "Coastal Engineering Technical Note, Side-Scan Sonar for Inspecting Coastal Structures," Coastal Engineering Notebook, CETN-III-16, Vicksburg, Miss.

Key Words: Side-scan sonar (or SSS), submerged objects, inspection

Abstract: This Technical Note presents a brief overview on side-scan sonar. After a typical system explanation, inspection methods, and interpretation of results are outlined.

REMR Interest: A fact sheet on the recent use of SSS to inspect structures, the methods used, interpretation, and contacts in various USAE District offices.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1984 (Nov). "Coastal Engineering Technical Note, Plastic Piling Jacket for Ice Protection," Coastal Engineering Notebook, CETN-III-17, Vicksburg, Miss.

Key Words: Ice, piling, protection

Abstract: This one-page Technical Note presents a method of protecting timber piles against ice forces. By wrapping the waterline area of the pile with a particular type of plastic, an ice collar formation is prevented and thus chafing and "jacking" caused by water level changes is reduced or eliminated.

REMR Interest: The plastic jacket may help prevent the jacking of piles due to ice in areas subject to water level raising and lowering.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1984 (Feb). "Coastal Engineering Technical Note, Monitoring Rubble-Mound Coastal Structures with Photogrammetry," Coastal Engineering Notebook, CETN-III-21, Vicksburg, Miss.

Key Words: Photogrammetry, surveys, procedure

Abstract: This Technical Note presents a brief overview on the use of photogrammetry in monitoring structures. Although more expensive than conventional methods, repetition surveys may, in certain instances, provide more accurate information. Procedures for a program are outlined.

REMR Interest: A fact sheet on the usefulness, procedure, and basic cost of photogrammetric surveys.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1981 (Dec). "Coastal Engineering Technical Note, Remote Sensing Application Guide," Coastal Engineering Notebook, CETN-I-9, Vicksburg, Miss.

Key Words: Remote sensing

Abstract: This Technical Note presents an overview of Engineering Phamphlet 70-1-1, "Remote Sensing Application Guide." Remote Sensing is defined and an expanded abstract of the guide is presented.

REMR Interest: Remote sensing applications.

Winkel, R., et al. 1934, 1931, 1933, and 1933. River Hydraulics. A donated volume to the US Army Engineer Waterways Experiment Station library with four different publications bound together.

Winkel: in German, no translation located.

Young: "Regulation of German Rivers and Comparisons with American practice," see separate Young abstract.

DuBoys: "The Rhone and Rivers of Shifting Bed," see separate DuBoys abstract.

VanFrank: "Random Notes on Improvement of Rivers," see separate VanFrank abstract.

REMR Interest: Historical value.

Young, G. R. 1931. Regulation of German Rivers and Comparisons with American Practice, File No. 211 Miscellaneous, US Army Engineer Office, Norfolk, Va.

Abstract: A pre-war survey of the Oder, Elbe, Danube, Rhine, and Waal Rivers versus the Mississippi and Missouri Rivers. Facts and figures were accurate along with problems, etc., however, between WWII and methodology changes it is of historical value.

REMR Interest: Historical value.

SCOUR AND SCOUR DAMAGE

SECTION

Carstens, M. R. 1966 (May). "Similarity Laws for Local Scour," Journal, Hydraulics Division, ASCE, Vol 92, HY-3, pp 13-36.

Key Words: Local scour, flow, sediment

Abstract: This study develops similarity criteria for sediment transport rate and for scour depth in localized-scour situations, with given restrictions. For application, a minimum of two model tests is required.

REMR Interest: A theoretical paper concerned with the mathematical prediction of local scour.

Central Board of Irrigation and Power. 1974 (Sep). "Research Scheme Applied to River Valley Projects, Scour at Bridge Piers - A Status Report," Status Report No. 4, New Delhi, India.

Key Words: Scour, bridge piers, research

Abstract: The report furnishes a critical review of the present-day knowledge on the subject of scour at bridge piers. Empirical formulae in use stemming from Lacey's regime formula for depth in alluvial streams are described. Extensive laboratory research carried out in recent years is referred to and the principle results are highlighted. Some important prototype observations of scour at bridge piers carried out by the Indian Railways are described and the analysis of the data collected is reviewed. The current design practice based on the findings of the laboratory research and field experience is clearly stated. The need for further collection of prototype data and for basic research on certain aspects not yet covered has been emphasized.

REMR Interest: Bridge pier scour and related research

Civil Engineering Department, University of Nebraska. 1968 (Jan). "Laboratory Investigation of Shoal Formation Below Large Piers in Alluvial Rivers," Contract DACW 45-67-C-0129, River Engineering Laboratory, Mead, Nebraska.

Key Words: Shoal, pier (bridge), scour depth

Abstract: The results of a model study on the effects of the large piers of the Union Pacific RR bridge on the location of the navigation channel of the Missouri River at Omaha, Nebraska is presented. The study did not indicate significant shoaling; however, below the piers, the model current pattern did correlate with prototype.

REMR Interest: The results of a 9-ft channel study at bridge piers.

Copeland, R. R. 1983. "Bank Protection Techniques Using Spur Dikes," MP HL-83-1, Hydraulics Laboratory, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Bank protection, local scour, spur dikes, protective aprons

Abstract: A hydraulic model investigation was conducted to evaluate and demonstrate the effects of impermeable spur dikes as a bank protection technique in a concave bend. The tests were conducted to observe channel bed and bank response in a stream with noncohesive banks where suspended load is insignificant. The parameters relative to spur dike design that were evaluated included: the length to spacing ratio, the orientation angle, and the effect of an apron or mattress as protection at the toe of the dike.

Although concerned with dike design, it also addresses erosion/scour. A few conclusions: (a) Spur dike roots should be protected from scour caused by vortices set up along up- and downstream faces; (b) Aprons are effective in limiting the depth of scour at the spur dike's toe; (c) The development of a scour hole at the toe of the spur dike may be retarded by the formation of an armor layer (armor of very coarse bed material - analyze bed samples); (d) Site specific model studies; (e) Existing scour protection equations at spur dikes are questionable for dikes in concave bends.

REMR Interest: Design oriented.

Cunha, L. V. 1976. "Time Evolution of Local Scour," Technical Memorandum No. 477, Laboratorio Nacional De Engenharia Civil, Lisbon, Portugal. (paper presented at the XVIth Congress of Int. Assoc. for Hydraulic Research, Sao Paulo, Brazil, July 1975)

Key Words: Local scour, sediment, scour depth, time

Abstract: After a discussion of scour evolution in flow with and without continuous sediment motion, Cunha presents the results of his flume studies. He considers flow without continuous sediment motion in flume tests with varied sand grain size and proposes an equation to predict scour depth based on his work and others.

REMR Interest: A theoretical paper concerning prediction of scour.

Das, B. P. 1973 (Dec). "Bed Scour at End-Dump Channel Constrictions," Journal, Hydraulics Division, ASCE, Vol 99, No. HY 12.

Key Words: Bed scour, alluvial channels, Froude number, end-dumped dams

Abstract: The study is concerned with bed scour that occurs around the leading face and downstream of end-dumped dams built into alluvial channels. Analysis of the problem indicates the Froude number of approach flow, the contraction ratio, and the ratio of the maximum scoured depth to the normal flow depth to be the essential nondimensional variables. The maximum scoured depth is observed to be influenced also by the size and density of the bed sediment.

REMR Interest: Theory oriented for end-dump type structures.

DeCoursey, D. G. 1981 (Apr). "Stream Channel Stability, Comprehensive Report, Project Objectives 1 through 5," USDA Sedimentation Laboratory, Oxford, Miss.

Key Words: Stream channel instability, watershed management, stabilization, sediment

Abstract: A Section 32 program report for the US Army Engineer District, Vicksburg, specific to the Yazoo River Basin but generalizes for other areas also. Topics include: grade control structures, monitoring stabilization methods, evaluating the physical nature of sediment source areas, estimating watershed source sediment versus channel stability, and evaluating valley stratigraphy and channel morphology with their effects on channel stability.

REMR Interest: An overview report concerning sediment and bank protection.

Degenhardt, E. A. 1973. Channel Stabilization of the Mississippi River, M.S. Thesis, Colorado State University, Fort Collins, Colo.

Key Words: Channel stabilization, navigation, bed scour

Abstract: An investigation of a 14-mile segment of the Mississippi River (between the Missouri and Ohio Rivers) concerning its physical history and the effects of channel stabilization on the river bed, alignment, contraction, and navigation.

REMR Interest: Overview of a 9-foot channel.

Dhamotharan, S., Dahlin, W. Q., and Wetzel, J. M. 1976 (Mar). "Model Studies of the Bed Regime of Alluvial Channels as Influenced by Submerged Groins," Project Report No. 159, University of Minnesota, St. Anthony Falls, Hydraulic Laboratory, prepared for US Army Engineer District, St. Paul.

Key Words: Alluvial channel, contraction, submerged groin, scour depth, stage

Abstract: Experimental studies were conducted in a straight reach of rectangular channel to determine the dynamic equilibrium depth of scour associated with submerged constrictions or groins. Tests were carried out with various groin geometries in both rigid- and movable-bed models. Velocity traverses were made over the groins and in the constricted region to establish the relationship between the ratio of discharge through the constriction to the total discharge and the relative groin submergence and geometry. Measurements of the eroded bed profile in the constricted region indicated that the equilibrium relative depth of scour was related primarily to the discharge ratio and the constriction ratio. All groin geometries tested demonstrated the capability of providing relatively large scour depths at low

stages, and less scour depths at high stages for which a larger portion of the total discharge passed over the groins. Reasonable agreement with predicted relative scour depths was noted for relatively large sediment transport rates. (Author)

The testing verified the concept of submerged groins controlling the scour depth in a constriction. However, the author's note that there are other factors to be considered, such as: consideration should be given to uniformity of scour depth across the entire constriction width, not just locally at the groins; groin type and longitudinal spacing depends on prototype conditions; type of reach beyond area of consideration. Although these are design factors, they can also be used in problem solving.

REMR Interest: Design oriented, also model studies.

Dhamotharan, S., Wetzel, J. M., and Dahlin, W. Q. 1977 (Nov). "Maintenance and Regulation of Navigable Channels by the Use of Submerged Contractions," 2nd International Symposium on Dredging Technology, British Hydromechanics Research Association, Cranfield, Bedford, England.

Key Words: Submerged contractions, alluvial rivers, navigation, scour, groins

Abstract: Existing experimental data have shown that submerged parallel contractions may be effective in controlling scour of alluvial river beds for the purpose of maintaining required water depths for navigation. A particular advantage of the submerged as compared to the unsubmerged contraction, is the capability of inducing scour at the lower discharges and water depths when it is needed, and reducing scour at the higher discharges and water depths when it is not actually needed. Further experimental studies were conducted in a straight reach of a rectangular channel to determine the dynamic equilibrium depth of scour associated with other types of submerged constrictions with groins. Tests were carried out with seven groin geometries in both fixed- and moveable-bed channels. Velocity traverses were made over the groins and in the constricted region to establish the relationship between the ratio of discharge through the constriction to the total discharge and the relative groin submergence and geometry.

REMR Interest: This paper is similar to the author's 1976 work to include model studies.

Dodge, R. O. 1971. "Design of Columbia River Pile Dikes," Journal, Waterways and Harbors Division, ASCE, Vol 97, No. WW2, pp 323-340.*

Key Words: Forces, stress, dikes, depth of penetration, piles, foundations

Abstract: Background and design methods are presented for piles in 40-ft channels. Addresses stone protection from scour, citing two

examples: Dike B-0.28 on Sand Island (mile 3), Columbia River Estuary for scour; and Dike 64.50 at Slaughters Bar for deflection by current. Also, a few pile dike construction details are given.

REMR Interest: Design equations may be outdated; however, possible follow-up on the two examples of stone protection as to status, also source of construction details, etc.

*Discussion: Sol M. Gleser, Vol 98, Feb 72, No. WW1, pp 126-132.
Closure: V 98, WW4, Nov 72, pp 582&3.

Garde, R. J., Subramanya, K., and Nambudripad, K. D. 1961. "Study of Scour Around Spur Dikes," Journal, Hydraulics Division, ASCE, Vol 87, No. HY6, pp 23-27.*

Key Words: Froude number, scour depth, spur dike, sediment, flow, opening ratio

Abstract: The paper presents the theoretical prediction of scour around spur dikes, then test results in a glass wall flume. The effect of flow, spur dike, and sediment characteristics on maximum scour depth was studied, and it was found that the Froude number of the normal channel, the opening ratio, the angle of inclination of the spur dike, and the average drag coefficient of the sediment particle adequately represent the effects.

REMR Interest: Design-calculation of scour hole depth (knowing sediment size). NOTE: Claims maximum scour with 90 deg dike angle, less scour with inclinations up and downstream. G. Tison Jr. discussion (TA1-A5; HY V.88) disagrees: max. scour upstream, less at 90 deg even less downstream.

*Discussions: Laursen, E. M., Vol 89, No. HY3, pp 225-228
Tison, G., Vol 88, No. HY4, pp 301-306
Closure: Vol 89, No. HY-1, pp 167-175.

Gill, M. A. 1972. "Erosion of Sand Beds Around Spur Dikes," Journal, Hydraulics Division, ASCE, Vol 98, pp 1587-1602.*

Key Words: Sediment grain size, scour depth and development

Abstract: The results of an experimental study of the problem of local scour around spur dikes are given. Conclusions: depth of equilibrium scour is affected by size of bed material (greater in fines) and depth of uniform flow upstream of spur. The depth of maximum scour occurs when the sand upstream of the spur is at the threshold of movement. For design, the distinction between clear water scour and scour caused by bed load transporting flows can be ignored.

REMR Interest: A theoretical paper dealing with the prediction of local scour.

*Discussion: Neill, C. R., HY V 99, May 73, pp 860-862.
Ramu, K.L.V., HY V 99, Aug 73, pp 1270-1274.
Stevens, M. A., and Simons, D. B., HY V 99, Sep 73 pp 1634-1637.
Cunha, L. V., HY V 99, Sep 73, pp 1637-1639.
Ahmad, M., HY V 99, Sep 73, pp 1639-1642

Gill, M. A. 1981 (Mar). "Bed Erosion in Rectangular Long Contraction," Journal, Hydraulics Division, ASCE, Vol 107, No. HY3.

Key Words: Bed scour, local scour, contraction, channel width, flow, erosion

Abstract: An experimental investigation into the general erosion within a long contraction problem is reported. The experimental results are used to verify Straub's theoretical one-dimensional model for general erosion. Local scour near the side walls in the inlet region was also measured and the results are reported. Two different sizes of sand were used in the experiments. The example cited is Mailsi Siphon, Pakistan, where the natural width of the Sutlej River is reduced from 12 km to 432 m.

REMR Interest: A model study of general interest.

Global Marine Development, Inc. 1985 (Jun). Seabed Strengthening Symposium - Proceedings, June 4, 1985, Denver, Colo.

Key Words: Cement, Deep Cement Mixing (DCM), weak foundation soils, injection

Abstract: The proceedings is a compilation of the seven papers presented at the symposium which dealt with weak marine foundation soils and deep cement mixing (DCM). Subjects addressed were the history and development of DCM in Japan, methodology, and several case studies/projects including arctic usage.

REMR Interest: Most applications cited have been marine and large projects, however, as the technology advances, the method may become a cost effective solution to riverine scour damage.

Hales, L. Z. 1980 (Mar). "Erosion Control of Scour During Construction, Report 1, Present Design and Construction Practice," Technical Report HL-80-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Construction practices, erosion control, harbor structures, scour

Abstract: The objective of this study is to develop techniques to minimize and control scour during nearshore construction and to predict probable magnitude of scour resulting as a function of wave climate.

REMR Interest: Coastal and Great Lakes regions, mainly.

Hales, L. Z. 1980 (Aug). "Erosion Control of Scour During Construction, Report 2, Literature Survey of Theoretical, Experimental, and Prototype Investigations," Technical Report HL-80-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Construction practices, erosion control, harbor structures, scour

Abstract: The objective of this study is to develop techniques to minimize and control scour during nearshore construction and to predict probable magnitude of scour resulting as a function of wave climate.

REMR Interest: Coastal and Great Lakes regions, mainly.

Hales, L. Z. 1980 (Sep). "Erosion Control of Scour During Construction, Report 3, Experimental Measurements of Refraction, Diffraction, and Current Patterns Near Jetties," Technical Report HL-80-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Construction practices, erosion control, harbor structures, scour

Abstract: The objective of this study is to develop techniques to minimize and control scour during nearshore construction and to predict probable magnitude of scour resulting as a function of wave climate.

REMR Interest: Coastal and Great Lakes regions, mainly.

Hjorth, P. 1975. "Studies on the Nature of Local Scour," Bulletin Series A,No. 46, Department of Water Resources Engineering, University of Lund, Lund, Sweden.

Key Words: Scour, pipelines, bridge pier scour, analysis, vorticity, pressure gradients

Abstract: The study is mainly concentrated on the mechanism of local scour process associated with pipelines and bridge piers and is restricted to the case of flow over an unscoured bed. Scour under pipelines is caused by pressure gradients in the bed (i.e., pressure difference between the stagnation zone upstream and the wake region downstream). Scour at bridge piers is dependent upon pier shape as it creates a specific boundary shear distribution based on upstream boundary shear and its Reynolds numbers; also weakly dependent on the ratios of pier width to boundary roughness and depth of flow to boundary roughness. The secondary flows generated by the test cylinders were found to be relatively weak. However, they are strong enough to reverse the flow in the lower layers in a region upstream of the cylinder. The sediment supply to the region near the cylinder

and to the wake region is thereby effectively blocked. This leads to a sediment deficit in these regions which has to be compensated for by scour. This mechanism is used to explain why a scour protecting layer is more effective when placed below bed level.

REMR Interest: Permeable pile dikes.

Karaki, S. S., and Haynie, R. M. 1963. "Mechanics of Local Scour," Part II, Report CER63SSK46, Civil Engineering Dept., Colorado State University, Fort Collins, Colo.

Key Words: Local scour, bibliography, bridge piers, flooding, shoaling

Abstract: The results of a literature survey on the various aspects of local scour in the form of a bibliography with abstracts.

REMR Interest: The bibliography is not limited to bridge piers and includes sediments, flow, shoaling, and a few training structures, but in print prior to 1963.

Keeley, J. W. 1971. "Bank Protection and River Control in Oklahoma," Federal Highway Administration, Oklahoma Division.

Key Words: Channel stability, bridge damage, control works, flood, pile diversion, rock dike, river control devices

Abstract: The results of a study concerning problem and repetitive damage to bridges on the Arkansas and Red Rivers. Twenty sites were studied to include river control structures, sediment, flood records, repair, maintenance, and river characteristics.

Although the study applies to bridges in not necessarily navigable waters, it does approach and deal with design, damage, and failure of river training structures. Several points brought out for failure are:

Overturning moment 1:1: current pressure against a pile crib causing lateral failure in the soil supporting the piles.
Drift impact: trees and heavy drift, especially at flood, damaging horizontal bracing and face planks.
Loss of pile support: dry weight of a tall unit exceeds buoyant uplift and frictional support of soil.

REMR Interest: Knowledge of local and flood conditions should be utilized during design period, i.e., study local conditions during design phase.

Koloseus, H. J. 1984. "Scour Due to Riprap and Improper Filters," Journal, Hydraulic Engineering, ASCE, Vol 110, No. 10, pp 1315-1324.

Key Words: Scour, channel

Abstract: Scour is usually associated with high velocities, elevated levels of turbulence, and negative piezometric gradients. Riprap and filters have been used to eliminate scour from these sources. Attention is drawn to piezometric gradients stemming from different levels of water about hydraulic structures and to the scour which might result from these gradients. A flow scheme is presented which demonstrates how piezometric gradients might be magnified in the vicinity of riprap; the magnified gradients could increase the amount of scour. Also, the flow scheme results in elevated pressures which tend to dislodge the riprap. In addition to controlling leaching, it is pointed out in this paper how proper filters eliminate both the magnified gradients and elevated pressures. Scour in a channel due to such natural occurrences as ponding, rainfall, and irrigation in the vicinity of a channel is examined.

REMR Interest: A theoretical paper with results applying to riprap and perhaps stone dikes, toe protection, etc.

Laursen, E. M., and Toch, A. 1953 (Aug). "A Generalized Model Study of Scour Around Bridge Piers and Abutments," Proceedings, Minnesota International Hydraulics Convention, Joint Meeting of IAHR and ASCE, University of Minnesota, Minneapolis, Minn., Sept. 1-4, 1953, pp 123-131.

Key Words: Scour, bridge piers, abutment, geometry, stream flow, sediment

Abstract: Four classes of variables are apparent in the problem of scour around bridge piers and abutments--geometry of piers and abutments, stream-flow characteristics, sediment characteristics, and geometry of site. The laboratory investigation, from its inception, has been divided into four phases based on these classes. In each phase, the variables in three of the classes are held constant and those in the pertinent class are varied. To date, the first three phases have been studied.

Typical scour hole patterns related to the geometry of the pier or abutment have been found. For equilibrium conditions of scour with uniform sand, the velocity of flow and the sand size do not appear to have any measurable effects on the depth of scour. This result is especially encouraging in the search for correlation between model and prototype since it would indicate that, primarily, only the depth of flow might be involved in the scale effect. The technique of model testing has been simplified, therefore, because rate of sediment transportation does not need to be scaled. Prior to the establishment of equilibrium conditions, however, depths of scour in excess of those for equilibrium conditions have been found. A concept of active scour as an imbalance between sediment transport capacity and rate of sediment supply has been used to explain the laboratory observations. (Author)

REMR Interest: Although a model study of the geometry of bridge piers, the tests provided the insight that contraction of the flow

and angle of attack are primary functions of scour while geometry is secondary.

Linder, W. M. 1967. "Erosion Experience Downstream of Bed Stabilization and Water Level Control Structures," Proceedings, 12th Congress, International Association of Hydraulic Research, Fort Collins, Colo., Sep 11-14, 1967, Vol 3, Paper C16, pp 135-142.

Key Words: Erosion, river bed, stabilization

Abstract: The experience of the US Army Engineers District, Omaha is described, that designed and built a number of flood control projects in the lower reaches of tributaries to the Missouri River. These projects have consisted of channel improvement or a combination of channel improvement with levees with sills and weirs for control to prevent erosion.

REMR Interest: This paper deals with stabilizing tributaries thus lessening sediments into the main channel.

Linear Composites Limited, Imperial Chemical Industries Limited. 1979 (Jun). "Linear Composites Erosion Control Systems, Type 3 On-Seabed System," Harrogate, North Yorkshire, England.

Key Words: Erosion control, scour, mat, interwoven fibers

Abstract: The problem of scour prevention near sea platform structures is addressed by this report. The Type 3 System is an assemblage of polypropylene fronds (as "artificial seaweed") on a high strength mat and lead or steel stakes to anchor to the bed. The system is to reduce near bottom velocity near the structure and, in some cases, precipitate sand around the structure.

REMR Interest: (A similar product being tested on east coast.) May be difficult to install in a high velocity or turbid environment; however, the company is looking into riverine applications.

Nece, R. E. 1974 (Jan). "Effectiveness of Bridge Pier Riprap in Washington State," Federal Highway Administration, Olympia, Washington.

Key Words: Bridge piers, scour, channel flow, river regulation

Abstract: A field study at seven bridge sites was conducted to evaluate the effectiveness of the method of riprap protection of bridge piers used in Washington State. The method consists of using protective riprap as a streambed-level scour arrester, with the riprap being dumped into place in an excavation surrounding the pier and with the top of the stone being placed at streambed level. Three solid-wall and four single, circular, cylindrical shaft piers were studied. Field methods are described, and correlation with hydraulic data are included where possible. Generally the method seems to have worked well, as little loss or subsidence of riprap was noted; however, some

of the bridges are fairly new and have not yet been subjected to major floods. On the basis of field observations, a modification is suggested for minimizing possibilities of scour concentrations between piers. Suggestions are included for routine inspection and maintenance of bridge piers and foundations in streams, and for more early attention to hydraulic considerations in pier location.

REMR Interest: Although the paper deals with bridge piers, the results and experience could apply to river training structures also.

Neill, C. R. 1964. "River Bed Scour," Technical Publication No. 23, Canadian Good Roads Association, Ottawa, Canada.

Key Words: River-bed scour, causes, bridge (scour), design data, field observations

Abstract: This report discusses the physical nature and causes of river-bed scour phenomena and outlines some of the findings of experimental research with a summary of published design data. Several case histories are presented and recommendations are given for dealing with scour in bridge design and maintenance to include field observation.

REMR Interest: Although dealing with scour at bridges, scour is explained and equations and data of others are reported.

Norman, V. W. 1974 (Nov). "Scour at Selected Bridge Sites in Alaska," Water-Resources Investigations 32-75, Water Resources Division, US Geological Survey, Anchorage, Alaska.

Key Words: Scour, bridge piers and piles, erosin, onsite investigation

Abstract: General scour at bridge crossings and local scour at bridge piers were measured at nine bridge sites in Alaska during the study period 1965-72. A detailed description of the physical setting, hydraulic characteristics, and channel geometry at low and high flows is given for each site to assist the reader in developing a background for the scour phenomenon in various situations. Flood discharges, during which scour data were collected, had recurrence intervals which range from approximately 2 years at some sites to about 100 years on the Tanana River at Nenana. General scour was minimal at crossings with no channel contraction. Measured general scour in contracted openings at three sites indicated mean depth of flow in contracted openings can be calculated by two established scour formulas to within 10 percent of the actual mean depth. Measured local equilibrium scour depth and bed material sizes at bridge piers were used to modify an existing pier scour formula to estimate maximum local equilibrium scour depth at round or pointed-nose piers aligned with the flow. The data suggest local equilibrium scour depth at piers during a mean annual flood is approximately as great as that which occurs during flood of greater magnitude.

Further field study is required to better define the effect of bed material size and pier nose shape on the equilibrium depth of pier scour. (Author)

REMR Interest: Unlike most theoretical papers on scour, this work is the results of a field study at selected locations for the period 1965-1972. Field measurements and data are compared to various scour formulas for surprising correlations with some adjustment. Good presentation on field work.

Oliver, A. C., and Woods, R. P. 1959. "The Resistance of Certain Timbers in Sea Defence Groynes to Shingle Abrasion," Timber Development Association, Ltd., London, England.

Key Words: Timber, abrasion, spill-over, scour, rate of wear, marine borer

Abstract: The rates of wear of piles and planking were tested on groynes made of seven different timber species installed on the Sussex (England) coast. Areas studied were species resistance to marine borer, shingle abrasion, spill-over, and scour.

REMR Interest: Applicable in wave and tidal affected channels for same mechanisms. (Timber species have to be correlated to North American types.)

Simons, D. B., Al-Shaikh-Ali, K. S., and Li, R. M. 1979 (May). "Flow Resistance in Cobble and Boulder Riverbeds," Journal, Hydraulics Division, ASCE, Vol 105, No. 5, pp 477-488.

Key Words: Open channel, sediment, bottom roughness, channel stabilization, flow resistance

Abstract: Field and experimental evidence are presented to demonstrate the importance of the inflow of sand and gravel size sediments on resistance to flow in channels whose beds are primarily cobbles, rocks, and boulders. The released sediments fill the spaces between the larger roughness elements, forcing the channel to behave as a sand bed channel at a much reduced resistance to flow coefficient. Resistance to flow in these channel decreases, resulting in underestimations of: (1) Water discharge by a factor of two; (2) sediment discharge by a factor ranging between 8 and 64; and (3) velocity of flow by a factor of two. Failure to estimate these quantities with a reasonable degree of accuracy results in the following: (1) Underestimation of the actual quantity of available (3) overestimation of reservoir life; (4) unsafe design of scour depths at hydraulic structures; (5) improper design of location; and (6) others relating to river control and development. (Authors)

REMR Interest: The paper stresses knowledge of specific reaches and sediment for proper design.

Simons, D. B., and Senturk, F. 1977. "Chapter 9, Degradation, Aggradation and Local Scour in Alluvial Channels," Sediment Transport Technology, Water Resources Publications, Fort Collins, Colo.

Key Words: Local scour, hydraulic structures, formulas, protection, sediment, scour depth

Abstract: This chapter presents mathematical methods to analyze and predict scour utilizing flow, sediment, and geometry of the structure.

REMR Interest: An analytical approach to scour prediction.

Task Committee on Channel Stabilization Works, Waterways & Harbors Division. 1964 (Feb). "Channel Stabilization on Alluvial Rivers; a paper for presentation at the Transportation Engineering Conference," ASCE, Cincinnati, Ohio

(also: Journal, Waterways and Harbors Division, ASCE, Vol 91, WW-1, pp 7-37, Feb 1965*).

Key Words: Channel stabilization, alluvial rivers, pile and stone dikes, revetments, bank erosion, jacks, jetties, erosion

Abstract: A summary of 28 papers dealing with current (1963) practices on channel stabilization on US rivers. A brief explanation on the causes and types of erosion and methods of stabilization are offered prior to a more thorough discussion of major river treatments. Glossary, references, and photos included.

REMR Interest: Excellent guide and format for reports. In general, gives methods and practices used in a number of areas at that time.

*Discussion: V 91, WW2, pp 59-60, Hertzberg, R.
V 91, WW3, pp 156-157, Neill, C. R.
V 91, WW4, pp 64, Moore, N. R.
pp 65, Fan, S. S.
pp 66, Turnbull, W. J., and Kolb, C. R.
pp 70-79, Chabert, J., and Remillieux, M.

Tison, G. 1962. Discussion of "Study of Scour Around Spur Dikes," Journal, Hydraulics Division, ASCE, Vol 88, No. HY4, pp 301-306.

Key Words: Maximum scour depth, inclination

Abstract: (See Garde et al., for "Study ..." HY6 pp 23-37) Tison's flume studies indicate that maximum scour occurs at upstream inclinations, less at 90 deg, still less downstream (Garde states max. scour at 90 deg).

REMR Interest: Further research on dike inclination in rivers.

US Army Engineer Committee on Channel Stabilization. 1969. "State of Knowledge of Channel Stabilization in Major Alluvial Rivers," Technical Report No. 7, US Army Engineer Waterways Experiment Station, G. B. Fenwick, ed., Vicksburg, Miss.

Key Words: Channel improvement; bank stabilization; revetments; cutoff; dikes: timber, steel, stone filled, asphalt concrete, L-head, angle to current, spacing of; sills; dredging; alignment

Abstract: A report consisting of eight chapters and prepared as an assessment of the "current" state of knowledge on open-river regulation measures in alluvial rivers. The chapters deal with soils, sediment, geomorphology, channel geometry, modeling, instrumentation and field survey, and channel improvement and stabilization in the final chapter. Among the methods discussed in this chapter, dikes and sills are presented to include design, types and shapes, and examples. There is also a section on scour.

REMR Interest: As of 1969, the Committee felt that analytical prediction of scour was in its infancy, and that general and site specific modeling be utilized along with field experience for design and problem study.

US Army Engineer District, Portland. 1965 (Nov). "Columbia and Lower Willamette Rivers, 35- and 40-foot Channel Modifications; Design Memorandum No. 8, Pile Dike Construction, FY 1967," Portland, Oreg.

Key Words: Control works, shoaling, dike, permeable, stone, scour protection, cutoff elevation, pile dike

Abstract: The proposed plan to build three new dikes on Lower Westport Bar and extend one dike on Upper Westport Bar, Columbia River and extending to depths ranging from 27 to 38 ft.

REMR Interest: Provides a pile dike design for a deep draft channel. For Corps of Engineers use only.

US Army Engineer District, Portland. 1984 (Sep). "Navigation Channel Improvement, Columbia River, Oregon and Washington-Longview to Kalama Reach, River Miles 64 to 78," Technical Report No. 118-1, Hydraulic Model Investigation, Portland, Oreg.

Key Words: Channel improvement, shoaling, scour, fill, pile dike systems

Abstract: A report of a model study of 20 different designs to improve the navigation channel and reduce shoaling. Tests included bank filling by dredge spoils within local interests. Pile dike systems are included in the various tests.

REMR Interest: Dredging oriented, but includes pile dikes.

US Army Corps of Engineers, Hydrologic Engineering Center. 1970. Proceedings of a Seminar on Sediment Transport in Rivers and Reservoirs, April 7-9, 1970, Davis, California.

Key Words: Inland waterways, rivers, sediment, channels

Abstract: Proceedings contain 15 papers discussing sediment problems encountered in water resource projects and classified as either technical or institutional. To the former category belong: predicting the amount and location of sediment deposits and channel degradation; bed forms; the effect of sediment on water quality and on environment. Problems involving navigation requirements and bank stabilization structures require detailed knowledge of sediment movement. As typical institutional problems, storage depletion in reservoirs and degradation downstream from dams were discussed.

REMR Interest: The papers consider water quality but stress the need for knowledge of sediment transport in design of training structures.

VanFrank, P. R. 1933. Random Notes on Improvement of Rivers, US Engineer Office, Memphis, Tenn.

(Subtitle: "Random Notes on Improvement of Rivers with movable bottoms for navigation and reference to cause of abandonment of attempt to improve the Arkansas River by permanent structures.")

Key Words: Sediment, scour, fill, control works, dikes, spurs, cut-offs, bar, regulation works

Abstract: Rather than random notes, the author should have entitled the work comparison notes. The first 10 pages contain a work history of improvements on the Arkansas River from 1877 through 1898. In the remainder of the text, the author compares and contrasts the findings and works of other authors concerning the results of training works constructed on various major rivers worldwide. Included at the end are the "running extracts" or sections of text of references from which the author cited.

REMR Interest: Although 42 years old, these notes do point out where and why certain projects did or did not perform.

Wall, W. J. 1962 (Feb). "Stabilization Works on the Savannah River," Journal, Waterways and Harbor Division, ASCE, Vol 88, No. WW-1, pp 101-116.

Key Words: Navigation, channel, revetments, piles, dikes

Abstract: A summary of the problems involved and the solutions proposed in developing open-river control works to obtain a relatively stabilized channel 9 ft deep in the Savannah River, Georgia.

REMR Interest: A summary of the problems encountered and plans of proposed dikes to be constructed are presented.

Winkley, B. R. 1971. "Practical Aspects of River Regulation and Control," Chapter 19, River Mechanics, edited and published by H. W. Shen, Colorado State University, Fort Collins, Colo.

Key Words: Open-channel control, cutoffs, levees, bank protection, navigation, channel, training structures, field experience, dikes, vanes

Abstract: This chapter deals primarily with the Lower Mississippi River and traces open-channel control methods historically through the present (1971). The various types of structures are presented along with their design, application, and associated problems.

REMR Interest: This paper provides insight, by experience, as to causes of failure and corrective measures.

REPAIR TECHNIQUES

SECTION

Burch, C. W., et al. 1984 (Sep). "Environmental Guidelines for Dike Fields," Technical Report E-84-4, Versar, Inc., Springfield, Va., and the Environmental Laboratory, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Environmental impact, design, construction, dikes, habitat improvement

Abstract: The report addresses environmental objectives, design procedures, and river-specific examples of currently employed features that can be used to maintain or increase fish and wildlife habitat diversity. Design, construction, and maintenance of dikes can alter the water depth, current velocity, and substrate composition. Features presented to increase diversity are notches, low-elevation dikes, rootless dikes, minimum maintenance practices, plus others. Two case studies are cited.

REMR Interest: Environmental impact on fish and wildlife habitats.

CIVIL ENGINEERING. 1985 (Mar). "Barmouth viaduct saved," London, p 31.

Key Words: Piles (timber), marine borer, scour, gabion

Abstract: This brief article summarizes the problem of marine borers on the timber piles of the Welsh Cambrian coastal railway system. The Mawddach Estuary at Barmouth drains almost completely at low tide, leaving scour pools around many of the timber piles. In these pools, the gribble worm (sea louse) and teredo (marine boring shipworm) acting in unison, attack the piles. The methods utilized to eliminate the problem are Glass Reinforced Cement (GRC) sheating on the piles and gabion mattresses on the bottom. The GRC sleeves prevent worm attack. The sandy bottom was filled with rock and covered with PVC-zinc coated wire gabion mattresses between pile bents. This prevented tide-induced scour and pools for the organisms to exist.

REMR Interest: Protection of timber piles against marine organisms and scour protection at pile mudline.

US Army Engineer Committee on Channel Stabilization. 1966 (Feb). "Symposium on Channel Stabilization Problems," Technical Report 1, Vol 4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Key Words: Inland waterways, dikes, construction, maintenance

Abstract: Symposium topics covered were: Channel stabilization work in the Vicksburg District; the stone-filled dike in the middle Mississippi River; potamology studies, hydraulic analysis of Mississippi River channels; bank stabilization, Red River below Denison Dam; program of the Mississippi River Commission; effectiveness of asphalt bank protection; river regulation works on the Apalachicola River; planning, construction, and maintenance of the stabilization works on the Savannah River.

REMR - Repair Techniques

REMR Interest: Reviews of projects that were current at that time.

World Dredging & Marine Construction. 1985 (Feb). "Mobile Diving System Performs Touch-Up Work," Vol 21, No. 2, p 22, WODCON Association, Irvine, Cal.

Key Words: Mobile diving system, closed-circuit TV, ultrasonic flaw detection, welding, cutting, grit blasting surface coating, 150-meter depths

Abstract: This one-page periodical article introduces the reader to a mobile deep-diving system as developed by Vriens Diving bv. A capsule was designed with a platform, from which divers can work, and a cabin below from which the work is directed and checked by closed-circuit TV. The system is also reportedly capable of ultrasonic crack and flaw detection, welding, cutting, grit blasting and surface coating, trenching, and rock breaking in depths down to 150 meters. The article also reports on the successful repairs made by this system on the Dutch East Scheldt storm surge barrier.

REMR Interest: The Vriens mobile deep-diving systems could find applications in maintenance and repair of submerged structures.

PART III: GLOSSARY

9. During the course of the literature search, an area of uncertainty was identified as to the definition and usage of terms. As an example, certain authors refer to the scour near a structure whereas other authors may refer to the same situation as local scour. In order to eliminate confusion, a glossary of various terms with definitions found in common literature use was included.

10. The glossary is not intended to encompass the entire field of hydraulic engineering but is presented under the general topic of training structures. It will also serve the reader in defining some of the key words.

ABRASION - Removal of streambank soil as a result of sediment-laden water, ice, or debris against the bank.

ACCRETION (also Aggradation) - The buildup of land, natural (by sediment deposition of water) or artificial (as formed by a dike, breakwater, etc.).

ALLUVIUM - Soil (sand, mud, or similar detrital material) deposited by streams, or the deposits formed.

ARMOR, ARMOR STONE, ARMOR PLATING - The upper layer or top stone placed on or around a structure or shore protection work and of a large enough size to protect the work from damage by wave action, current, scour, etc.

ARTICULATED CONCRETE MATTRESS - Rigid concrete slabs usually hinged together with corrosion-resistant wire fasteners; primarily for lower bank protection.

AUTHORIZED DEPTH - The depth of channel provided for by regulation (regulation, in this definition, meaning the US Congress).

AUTHORIZED DIMENSIONS - The dimensions (width, depth) of a channel provided for by regulation (regulation, in this definition, meaning the US Congress).

BANK - The rising ground bordering a lake, sea, river, or channel (which, for river and channel, it is designated as right or left as the observer is facing downstream).

BANK PROTECTION; STREAMBANK PROTECTION WORKS - Structure(s) placed on or near a distressed streambank to control bank erosion or to prevent failure.

BAR - A sand or gravel deposit found on the bed of a stream that is often exposed only during low-water periods.

BED - The bottom of a channel.

BED LOAD - The sediment carried by the river in constant or very frequent contact with the river bed. Also, the quantity of sediment transported by a current that moves along the bottom.

BED SLOPE - The inclination of the channel bottom (vertical, usually expressed as drop in feet per mile).

BENCHMARK - A fixed physical object or marks used as reference for a vertical datum. A Geodetic bench mark identifies a surveyed point in the National Geodetic Vertical Network.

BEND - A change in the direction of a stream channel.

BREAKWATER - A structure protecting a shore area, harbor, anchorage, or basin from short period waves.

BULKHEAD - A structure or partition to retain or prevent sliding of the land; secondary purpose is to protect the upland against damage from wave action.

CAVING - The collapse of a streambank by undercutting due to wearing away of the toe or an erodible soil layer above the toe.

CHANNEL - A natural or man-made waterway that continuously or periodically passes water. The part of a body of water deep enough to be used for navigation. Also, the deepest part of a stream through which the main volume or current of water flows.

CHANNEL MAINTENANCE - Dredging of obstructions and other operations which assure or maintain the navigability of a channel.

CHANNELIZED RIVER - A river that is deepened in parts in order to provide a navigable waterway.

CHECK DAM - A structure placed bank to bank downstream from a headcut.

CONFINED DISPOSAL - For dredged material, disposal in an area enclosed by dikes or levees.

CONTROLLING DEPTH - The minimum depth of a channel, which determines the maximum draft of the vessels utilizing the waterway.

CORE - A vertical cylindrical sample of the bottom sediments from which the nature and stratification of the bottom may be determined.

CREST - The flat upper surface or top of a dike.

CRIB - An open-frame structure filled with earth or stone ballast designed to absorb energy and to deflect currents away from a streambank or structure.

CURRENT - The flow of water through a stream channel. Currents are classified as tidal or nontidal. Usually expressed as miles or knots per hour, or feet per second.

CUTBANK - The outside bank of a bend, often eroding and across the stream from a point bar. The concave wall of a meandering stream that is maintained as a steep or overhanging cliff by the impinging streamflow against its base.

CUTOFF - A channel cut across the neck of a bend. The closure of a bend, either by natural meandering of the stream or man-made.

DEEP DRAFT CHANNEL - Channels provided for the movement of vessels with drafts of more than 15 ft, designed for open-water navigation, including seagoing and intracoastal vessels, and vessels operating on the Great Lakes.

DIKE [Dyke - British] - A timber structure or an embankment that is constructed to control or redirect flow in a channel. (Also groin, spur, jetty, deflector) A structure designed (1) to reduce the water velocity as streamflow passes through the dike so that sediment deposition occurs instead of erosion (permeable dike), (2) to deflect erosive currents away from the streambank (impermeable dike), or (3) constrict or direct flow so as to keep sediment transport capacity high and reduce deposition or cause erosion of the bed. Other names used: groin (or groyne), contracting dikes, transverse

dike, cross dike, spur dike, spur dam, cross dam, wing dam, spur, jetty, and sill.

DISTRESSED STREAMBANK - A bank that has (or is) suffering erosion or failure.

DOLPHIN - A cluster of piles.

DRAFT - The depth of water displaced by a vessel.

ECHO SOUNDER - An electronic instrument used to determine the depth of water by measuring the time interval between the emission of a sonic or ultrasonic signal and the return of its echo from the bottom.

E.I.S. - Environmental Impact Statement.

END DUMP STRUCTURE - A structure such as a dam or rubble dike that is constructed from land into the waterway by trucks dumping stone directly from its crest and progressing until design length is reached.

FASCINE - A bundle of sticks or small (sapling) trees bound together. Bundles are then lashed together and placed on the bottom (facine mattress) or near a structure for protection.

FATHOM - A unit of measurement equal to 6 ft (1.83 m) used for soundings.

FATHOMETER - The copyrighted trademark for a type of echo sounder.

FLANKING - Streamflow between a structure and the bank, possibly occurring because the structure was not properly tied into the bank.

FLOW REGULATION - The control of the flow of the waterway by river training or scheduled release of water from reservoirs.

FREE FLOWING RIVER - A river unregulated by a system of locks and dams.

FUSEPLUG - Certain places in a levee are deliberately made weaker than the standard section thereby predetermining that breaks in the levee, should they occur, are situated to cause minimum damage.

GABION - A wire enclosed "block" filled with stone, and aligned, stacked, and attached to others as a form of bank protection/channel training work.

GENERAL SCOUR - See scour.

GUIDE BANK - (India) In US, a spur dike.

GUIDING SHIELD - A type of structure to induce a more favorable flow in direction (as away from the bank) or velocity (as to slow to deposit suspended sediments).

GROIN - (Groyne - British) See dike.

HARDPOINT - A spur of rock or stone that extends from bank into the stream to stabilize streambank. Hardpoints are not suitable for rapidly eroding banks or critical locations since some erosion continues until equilibrium is reached.

HEADCUTTING - The action of an upstream moving waterfall or locally steep channel bottom with rapidly flowing water through an otherwise placid stream. These conditions often indicate that a readjustment of a stream's discharge and sediment load characteristics is taking place.

HYDRAULICALLY EQUIVALENT GRAINS - Sedimentary particles that settle at the same rate under the same conditions.

HYDROGRAPHY - A configuration of an underwater surface including its relief, bottom materials, etc. Description and study of rivers, lakes, and other waters.

IMPERMEABLE MATERIAL - A material or soil that has properties which prevent movement of water through the material.

INCLINATION - The angle of a dike versus the bank at that location, e.g., the dike is perpendicular (to the bank).

IOWA VANE - See submerged vane.

ISOBATH - A contour line connecting points of equal water depths on a chart.

JETTY (also training wall) US usage - On open seacoasts, a structure extending into a body of water which is designed to prevent shoaling of a channel by littoral materials and to direct and confine the stream or tidal flow. Jetties are built at the mouths of rivers or tidal inlets to help deepen and stabilize a channel. British usage - Wharf or pier.

KNOT - The unit of speed used in navigation equal to 1 nautical mile (6,076.115 ft or 1,852 m) per hour.

LAUNCHING - Process where stone stockpiled along top bank is undercut and slides downslope thus protecting the bank against future erosion.

LEVEE - An embankment to protect land from inundation during high water and floods.

LOAD - The quantity of sediment transported by a current. It includes the suspended load of small particles and the bedload of large particles that move along the bottom.

LOCAL SCOUR - Removal of underwater material by waves and currents especially at the base of the toe of a structure. See Scour also.

LOWER BANK - That portion of the streambank below the elevation of the average water level of the stream.

MHW, MHHW, MLW, MLWS, MLLW, MRL, MSL, and MTL - Abbreviations describing various levels in tidal waters. See NOAA, National Ocean Service Tide Tables for explanation.

MOLE - See Breakwater.

NAVIGABLE STREAMS - Waterways of sufficient depth and width to handle a specified traffic load.

NOAA - National Oceanic and Atmospheric Administration, US Dept. of Commerce.

NOS - National Ocean Survey.

OVERTOPPING - Passing of water over the top of a structure as a result of wave runup, surge action, or high water.

PARAPET - A low wall built along the edge of a structure such as a seawall or quay.

PASS - In hydrographic usage, a navigable channel through a bar, reef or shoal, or between closely adjacent islands.

PERMEABLE DIKE - (permeable groin) See Dike.

PILE - A long, heavy timber or section of concrete or metal to be driven or jetted into the earth or riverbed to serve as support or protection.

PILE, SHEET - A steel pile with a generally slender, flat cross section to be driven into the earth or riverbed and meshed or interlocked with like members to form a diaphragm, wall, or bulkhead.

PILING - A group of piles.

PROTOTYPE - In laboratory usage, the full-scale structure, concept, or phenomenon used as a basis for constructing a scale model or copy.

PLACE - Synonym for construct; for example, to say that "a riprap revetment was placed on the streambank" is the same as saying "constructed."

POINT BAR - The bank in a bend that has built up due to sediment deposition.

QUAY (pronounced KEY) - A stretch of paved bank, or a solid artificial landing placed parallel to the navigable waterway, for use in loading and unloading vessels.

RAPID DRAWDOWN - Lowering elevation of water against a bank faster than the bank can drain leaving a pressure imbalance that may cause the bank to fail.

REGULATION TRACE (European term) - The particular reach of a river which is to be trained or regulated.

REACH - A channel segment between two given points on a waterway. A section of a stream's length.

REVETMENT - Material; natural or artificial, used for bank protection. A facing of stone, bags, blocks, pavement, etc., used to protect a bank against erosion by wave action or currents.

RIPRAP - A protective layer or facing of quarrystone, usually well graded within wide size limits, randomly placed to prevent erosion, scour, or sloughing of an embankment; also, the stone so used.

RIVER MILE - A number specifying the location of a point along a waterway, obtained as the distance from a reference point designated as mile zero near the mouth or confluence.

RIVER STABILITY - The measure of a river's ability to maintain its features for long periods of time.

RIVER TRAINING - The regulation of river flow utilizing dikes and revetments.

RIVER TRAINING WORKS - Structures placed in a stream to direct the current into a predetermined channel.

ROOTED - An expression indicating that a bank has been excavated and the end of a structure (check dam, dike, etc.) has been placed in the cavity, thus retarding future streamflow around the end of the structure (flanking).

RUBBLE-MOUND STRUCTURE - A mound of randomly shaped and randomly placed stones protected with a cover layer of selected stones or armor units.

SANDBAR - See Shoaling.

SCOUR - The erosive action of flowing water in streams that removes and carries away material from the bed and banks. There are three types of scour: (1) Local scour - in the immediate vicinity of the structure as a result of disturbed flow patterns around the structure; (2) General scour - occuring in the vicinity of the entire structure as a result of increased velocity caused by contraction of the flow area, and (3) Streambed scour - as a result of upsetting of the equilibrium of the stream flow.

SEDIMENT - Soil particles that have been transported away from their natural location by wind or water action.

SEDIMENT DEPOSITION - The accumulation of soil particles on the channel bed and banks.

SEDIMENT LOAD - The quantity of soil particles transported through a channel by streamflow.

SHINGLE ABRASION - Damage to a structure as a result of sediment-laden water, ice, or debris rubbing against it.

SHOALING - The building up of a waterway bed through deposition of sediments.

SILL - The upstream and downstream boundaries of a lock chamber. See check dam.

SLAR - Acronym for side-looking airborne radar.

SLOUGHING; SLOUGHING OFF - Movement of a mass of soil down a bank into the channel (also called slumping; similar to a landslide).

SPILL-OVER - As a result of wave action, the overtopping of a structure with the water going behind it.

SPUR DIKE (also Spur) - A structure, approximately normal to the river bank, attached to the river bank, contracts the natural river channel, but does not transverse the entire river channel.

STREAM-BED SCOUR - See Scour.

SUBMERGED VANE - A structure used in series, paralleling the channel and low in profile to control flow and erosion.

THALWEG - In hydraulics, the line joining the deepest points of an inlet or stream channel.

TIED IN - An expression used to indicate that a revetment or dike is constructed to prevent or minimize streamflow between the structure and the bank.

TOE - The break in slope at the foot of a bank where the bank meets the bed. The lower streamward end of a structure, as "the toe of the dike."

TOP BANK - The break in slope between the bank and the surrounding terrain.

TRACTIVE FORCE - The drag on a streambank caused by passing water which tends to pull soil particles along with the streamflow.

TRAINING WALL - A wall or jetty to direct current flow.

TRAINING WORKS - Structures such as dikes and revetments placed along river channels to increase runoff capacity, prevent bank erosion, and stabilize the location of the channel.

UPPER BANK - That portion of the streambank above the elevation of the average water level of stream.

USGS - US Geological Survey (US Department of the Interior)

VANE - A structure similar to a rubble mound dike but is not tied to the bank and runs parallel to the bank to help control the flow and bank erosion.

WATERWAY - Any body of water wide enough and deep enough to accommodate the passage of water craft, particularly commercial vessels.

WAVE ATTACK - Impact of waves on a streambank (can be generated by passing ships or winds.

WEEPHOLE - Opening left in a revetment or bulkhead to allow ground-water drainage.

GLOSSARY REFERENCES

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